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U. S. Nuclear Regulatory Commission
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**RESPONSE TO GENERIC LETTER 2004-02
POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON
EMERGENCY RECIRCULATION DURING DESIGN BASIS
ACCIDENTS AT PRESSURIZED-WATER REACTORS
SALEM GENERATING STATION UNITS 1 AND 2
FACILITY OPERATING LICENSE NOS. DPR-70 AND DPR-75
DOCKET NOS. 50-272 AND 50-311**

On September 13, 2004 the NRC issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors." GL 2004-02 requested that each plant perform an evaluation of the Emergency Core Cooling System and Containment Spray System recirculation functions in light of the information provided in the Generic Letter and, if appropriate, take additional actions to ensure system function.

The response to GL 2004-02 was to be provided in two (2) sections: (1) a 90-day response from the date of the safety evaluation, and (2) additional information to be provided by September 1, 2005. PSEG Nuclear LLC satisfied the 90-day response by letter dated March 4, 2005 (PSEG reference LR-N05-0103).

Attachment 1 to this letter contains the additional information that was requested to be provided by September 1, 2005.

Should you have any questions regarding this submittal, please contact Mr. Enrique Villar at 856-339-5456.

A114

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 9/1/05

Sincerely,

Thomas P. Joyce

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REQUESTED INFORMATION:

This attachment provides responses to Part 2 of Generic Letter (GL) 2004-02 for Salem Generating Station Units 1&2 (SGS 1&2). The following information is provided as separate responses to the sub-paragraphs identified in Part 2 of the GL information request.

2. Addressees are requested to provide the following information no later than September 1, 2005:

(a) Confirmation that the ECCS and CSS recirculation functions under debris loading conditions are or will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of this generic letter. This submittal should address the configuration of the plant that will exist once all modifications required for regulatory compliance have been made and this licensing basis has been updated to reflect the results of the analysis described above.

SGS 1&2 Response

(a) SGS 1&2 Emergency Core Cooling Systems (ECCS) and Containment Spray Systems (CSS) recirculation functions will be in compliance with the regulatory requirements listed in the Applicable Regulatory Requirements section of the subject generic letter under debris loading conditions.

Response 2.(b), below, describes the corrective actions required to ensure this compliance. All additional information provided relates to the plant configurations following completion of the described corrective actions.

Sargent and Lundy (S&L) has performed the GSI-191 evaluations, and Control Component Incorporated (CCI) has been selected as the screen vendor. The SGS 1&2 containment walkdowns, debris generation calculation, debris transport and head loss calculation, downstream effects evaluations for blockage, and the screen procurement specifications have been completed by S&L.

The chemical effects evaluation is in progress and is scheduled to be completed once the test results to quantify the chemical debris effect on head loss have been published. The final designs of the strainers and the Design Change Package finalizing the "as-modified" plant configuration are in progress and will extend beyond the September 1, 2005 due date as a result of vendor testing that is to be performed in September 2005. The final design is expected to be issued by the Spring and Fall 2006 for SGS 2&1,

respectively. The SGS licensing basis and this response will be revised to reflect the final plant configuration when the design is finalized and plant modifications are completed.

NRC Requested Information

(b) A general description of and implementation schedule for all corrective actions, including any plant modifications that you identified while responding to this generic letter. Efforts to implement the identified actions should be initiated no later than the first refueling outage starting after April 1, 2006. All actions should be completed by December 31, 2007. Provide justification for not implementing the identified actions during the first refueling outage starting after April 1, 2006. If all corrective actions will not be completed by December 31, 2007, describe how the regulatory requirements discussed in the Applicable Regulatory Requirements section will be met until the corrective actions are completed.

SGS 1&2 Response

(b) Based on the results from debris generation and transport analyses identified and described below, modifications to the existing debris screen will be required to meet the applicable Regulatory Requirements discussed in the generic letter.

Current evaluations indicate that a new sump strainer with a surface area in the range of approximately 1700 to 8500 square feet with 0.083 (1/12) inch diameter perforations will be used. The final area will be determined once the vendor designs are complete. This area includes 500 square feet of sacrificial surface area for tape, labels, etc. The new strainers will occupy the space around the existing sump as well as an area around the circumference of the containment wall. Modifications to the containment sump level instrumentation will be made to reduce the instrument uncertainty.

Implementations of the sump strainer plant modifications are scheduled for the Fall 2006 outage for Unit 2 and the Spring 2007 outage for Unit 1.

NRC Requested Information

(c) A description of the methodology that was used to perform the analysis of the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage and operation with debris-laden fluids. The submittal may reference a guidance document (e.g., Regulatory Guide 1.82, Rev. 3, industry guidance) or other methodology previously submitted to the NRC. (The submittal may also reference the response to Item 1 of the Requested

Information described above. The documents to be submitted or referenced should include the results of any supporting containment walkdown surveillance performed to identify potential debris sources and other pertinent containment characteristics.)

SGS 1&2 Response

(c) The analysis of the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage was performed using the methodology in the NEI guidance document NEI 04-07 (Reference 1), as modified by the NRC's Safety Evaluation Report (SER) for NEI 04-07 (Reference 2). Containment walkdowns to support the analysis of debris blockage were performed using the guidelines provided in NEI 02-01 (Reference 3).

Background

SGS Units 1&2 contain four Reactor Coolant System (RCS) loops (designated as loops 11 (21), 12 (22), 13 (23), and 14 (24)) within each containment. Each loop consists of one steam generator (S/G), one reactor coolant pump (RCP) and the associated RCS piping. All four loops are located within a single annular bioshield wall. The pressurizer (PZR) and the pressurizer surge line piping are near S/G 13 (23).

Since the debris generation calculation addresses both units, a review of the physical plant layout was performed to ascertain any differences between the units that might affect this calculation. The review concluded that both units have similar containment layouts. Where differences exist, the more conservative values were used. Otherwise, Unit 1 is considered to be representative.

Break Selection

Several break locations were selected for evaluation following the guidance of Regulatory Guide 1.82, Revision 3. Breaks in Feedwater and/or Main Steam System piping were not considered because they do not require the ECCS and/or CSS to operate in recirculation mode. In accordance with NEI 04-07, small-bore piping (2" nominal diameter and less) was not considered since the impact is bounded by the larger breaks. The selected breaks are as follows:

Break 1 is a 29-inch internal diameter (ID) break in the S/G 13 hot leg at the primary shield wall penetration. A break at this location would affect most of the pressurizer, S/G 11 and S/G 13 insulation. This break generates a significant amount of fibrous insulation and qualified coatings debris.

Break 2 is a 27.5 inch ID break in the S/G 13 cold leg piping at the RCP discharge connection. A break at this location would affect a significant portion of the pressurizer and S/G 13 insulation as well as a portion of the S/G 11 insulation. This break is slightly smaller, but includes a different mix of insulation. The RCPs are insulated with reflective metallic insulation (RMI), so this break will increase the amount of RMI debris generated compared to other break locations.

Break 3 is a 29-inch ID break in the S/G 12 hot leg at the primary shield wall penetration. This break is nearly identical to Break 1 and was selected to give debris loading for other transport paths.

Break 4 is at the pressurizer surge line connection to the RCS hot leg. This break was selected because the pressurizer surge line is a 14-inch Schedule 160 line and generates more fibrous debris than a partial break in the RCS piping due to its proximity to S/G 13.

Break 5 is in the pressurizer surge line at the pressurizer nozzle. This break provides a similar amount of debris as Break 4, but at the Safety Injection accumulator 13 stairway. This was included to address debris transport.

Break 6 is a 31-inch ID break in the S/G 11 crossover pipe at the discharge of the 90° elbow below the S/G. This break is not limiting from a debris generation standpoint, but was included to address debris transport.

Debris Generation

Insulation

With the exception of Kaowool and Transco fiber, insulation debris types were quantified using the Zone of Influence (ZOI) radius specified by the SER in Table 3-2 (Reference 2). For Kaowool and Transco fiber, a ZOI radius equivalent to that of unjacketed Nukon (17.0D) was used based on the guidance of NEI 04-07, §4.2.2.2.5. For all piping insulation debris, a 3D model was used to identify piping within the ZOI and calculate the impacted insulation volume. For all equipment insulation, the sections of insulation within the ZOI were determined based on dimensioned insulation and plant layout drawings.

Coatings

Qualified coating debris was quantified using the ZOI radius of ten pipe diameters (10.0D), as specified by the SER in Section 3.4.2.1. The concrete and structural steel coatings within the ZOI were determined based on dimensioned plant drawings. For the purpose of determining impacted coating volumes, the coated surfaces within the ZOI were assumed to have the maximum of the thickness values specified by the coatings specifications or measured values. An additional 25% of the total qualified steel coating debris volume was included to account for gratings and any other metal surfaces not tabulated. In accordance with NEI 04-07 and the SER, all unqualified coatings were considered to fail regardless of their location within containment. Similarly, all qualified coatings that have been identified as being degraded were considered to fail regardless of their location within containment.

Foreign Material

The quantity and type of foreign material inside containment was based on a walkdown performed for SGS Unit 1. The foreign material included self-adhesive labels and placards.

Latent Debris

In the debris generation calculation, it was assumed that there is 200 lbm of latent debris in the containment. A latent debris walkdown was subsequently performed in SGS Unit 2 in accordance with the NEI/SER guidelines in Section 3.5. Using cloths, samples were collected from the various surfaces at different floor elevations and when practical, different locations on each floor. Samples from each of the following surfaces were taken:

- Horizontal concrete surfaces (floors)
- Vertical concrete surfaces (walls)
- Containment liner (vertical)
- Cable trays (horizontal)
- Horizontal equipment surfaces (Heat Exchangers, Air Coolers, etc.)
- Vertical equipment surfaces (SG, Air Coolers, Pressurizer, etc.)
- Horizontal HVAC duct surfaces
- Vertical HVAC duct surfaces
- Horizontal piping surfaces
- Vertical piping surfaces (Pipes running vertically)

A total of 38 samples were taken. When a surface was not accessible for sampling, an alternate surface was selected and noted on the walkdown report, such as circular pipe for an inaccessible circular duct. The net weight differences between the pre-sample and post-sample weight were used to statistically extrapolate the amount of latent debris for the entire containment using a 90% confidence level. Based on this walkdown analysis, 33 lbm of latent debris was identified.

Debris Transport

The transport of the debris from the break location to the sump screen is evaluated using the methods outlined in §3.6 of NEI 04-07 as amended by the NRC SER. The means of transport considered are blowdown, washdown, pool fill and recirculation for all types of debris. The recirculation transport analysis was performed using computational fluid dynamics (CFD) models developed using the computer program FLUENT. Outputs of the CFD analysis include global (entire containment) and local (near sump pit) velocity contours, turbulent kinetic energy (TKE) contours, path lines and flow distributions for various scenarios. The CFD analysis modeled scenarios both with and without flow through the inner and outer trenches in containment.

Fibrous (Nukon and Kaowool) debris was characterized into four debris size categories based on the interpretation of the Boiling Water Reactor (BWR) Owner's Group Air-Jet Impact Test (AJIT) data: fines (8%), small pieces (25%), large pieces (32%) and intact piece debris (35%). All fines are considered to transport to the screen. Based on the comparison of recirculation pool velocities determined using CFD analysis with incipient debris tumbling velocities and lift over curb velocities provided in NUREG/CR-6772, a portion of the small and large fiber pieces transport to the screen in some cases. Erosion of small and large piece fiber debris modeled for debris that does not transport to the screen. Intact debris does not erode or transport to the screen. All particulate and coating debris was modeled as fines and 100% transport to the screen.

The RMI size distribution is based on the categorization provided in NEI 04-07. For Transco RMI, the values used are 75% fines and 25% large debris. All fines are considered to transport to the screen. Based on the comparison of recirculation pool velocities, determined using CFD analysis with incipient debris tumbling velocities, and lift over curb velocities provided in NUREG/CR-6772, a portion of the large RMI pieces transport to the screen in some cases. Erosion of RMI debris is not modeled.

Insulation jacketing/lagging does not transport to the screen in any case based on the comparison of recirculation pool velocities determined using CFD analysis with incipient debris tumbling velocities provided in NUREG/CR-3616.

The debris transport phenomena due to the blowdown, washdown, pool fill-up and recirculation transport modes are summarized using debris transport logic trees consistent with the Drywell Debris Transport Study (DDTS) documented in NUREG/CR-6369. The debris transport logic trees consider the effect of dislocation, hold up on the floor or other structures, deposition in active or inactive pools, lift over curbs, and erosion of debris.

Miscellaneous (foreign material) debris (tape, labels, etc.) is not included in the debris load at the sump screen when determining debris bed head loss, but is considered in the screen design as a sacrificial area. All miscellaneous debris is 100% transportable.

The following is a summary of the overall transport fractions for all debris types for two cases. Case 1 presents the transport fractions for the break which generates the most debris while Case 2 presents the transport fractions for the break which yields the highest transport fractions.

Debris Type	Case 1 Transport Fraction	Case 2 Transport Fraction
Nukon	0.64	0.65
Kaowool (Unit 2 only)	0.64	0.65
Transco RMI	0.77	0.79
Qualified Coatings	1.00	1.00
Unqualified Coatings	1.00	1.00
Latent Debris	1.00	1.00
Foreign Material	1.00	1.00

Strainer Head Loss

The final strainer head loss analysis will be performed by the strainer vendor, CCI, and will be documented in the DCP scheduled to be issued by the Spring and Fall 2006 for SGS 2&1, respectively.

The preliminary analysis of debris bed head loss and NPSH margin determines that the existing sump screen cannot accommodate the debris inventory transported to the sump screen based on the head loss through the debris bed, which would form during recirculation. In this scoping evaluation, the head loss across the debris bed is determined separately for fiber and particulate debris, and for RMI debris. The head loss through a fiber/particulate debris bed is determined using the head loss correlation developed in NUREG/CR-6224 while the RMI debris bed head loss is determined using the correlation recommended in NUREG/CR-6808. The total head loss across the sump strainer is equal to the sum of the fiber/particulate debris bed head loss, the RMI debris bed head loss, and the clean strainer head loss. Specific detailed information regarding the type(s) of unqualified coatings at SGS 1&2 is not readily available. Therefore, in the determination of debris bed head loss, all unqualified coatings are assumed to be epoxies. All particulate is modeled with a sludge density of 65 lbm per cubic feet. In addition, Kaowool is modeled with an as-fabricated density of four (4) lbm per cubic feet and the latent debris quantity is 200 lbm in the analysis. In determining the quantity of RMI foil at the sump screen, three (3) foils per inch of RMI insulation thickness are modeled.

The scoping evaluation estimates a strainer with a surface area range of approximately 1700 to 8500 sq. ft. is required, which includes a sacrificial area of 500 sq. ft. for foreign material. The strainer size estimates are provided based on the case where both Residual Heat Removal (RHR) pumps are running following switchover with one RHR pump operating in cold leg recirculation mode and the other RHR pump operating in containment spray mode.

The containment spray pumps do not operate during recirculation.

The screen size estimates are based on an allowable head loss of 3.15 feet with 0.33 feet Net Positive Suction Head (NPSH) margin retained.

The design specification requires that void fraction and flashing downstream of the sump screen and at the RHR pump inlet will not present a challenge to operability at SGS.

<u>Containment Walkdowns</u>

Containment walkdowns to support the analysis of debris blockage were performed for SGS 1&2 using the guidelines provided in NEI 02-01.

NRC Requested Information

(d) The submittal should include, at a minimum, the following information:

(d)(i) The minimum available NPSH margin for the ECCS and CSS pumps with an unblocked sump screen.

SGS 1&2 Response

(d)(i) The minimum currently available NPSH margin for the ECCS (RHR) pumps in the cold leg recirculation and containment spray recirculation modes at switchover to sump recirculation, not including the clean screen head loss or retained margin, is 3.48 feet. The clean screen head loss is small (<0.1 feet based on experience). However, the exact values will only be known when the vendor screen design is complete.

The CSS pumps are not used in the sump recirculation mode.

NRC Requested Information

(d)(ii) The submerged area of the sump screen at this time and the percent of submergence of the sump screen (i.e., partial or full) at the time of the switchover to sump recirculation.

SGS 1&2 Response

(d)(ii) The bid specification requires the strainers to be fully submerged (submergence of 100%) for both large and small break Loss of Coolant Accidents (LOCAs). The strainers also have a minimum of three (3) inches of water above the top of the strainer at switchover.

NRC Requested Information

(d)(iii) The maximum head loss postulated from debris accumulation on the submerged sump screen, and a description of the primary constituents of the debris bed that result in this head loss. In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) and CSS washdown should be considered in the analyses. Examples of this type of debris are disbonded coatings in the form of chips and particulates and chemical precipitants caused by chemical reactions in the pool.

SGS 1&2 Response

(d)(iii) The maximum postulated head loss from debris accumulation on the submerged sump screen is specified to be 3.15 feet of water or less. The primary constituents of the debris bed at the sump screen are as follows:

Debris Type	Unit 1	Unit 2
Nukon	1,200 ft^3	600 ft^3
Kaowool	0 ft^3	600 ft^3
Transco RMI Foil	1,525 ft^2	1,525 ft^2
Qualified Coatings (epoxy)	25.5 ft^3	25.5 ft^3
Unqualified Coatings epoxy)[1]	0.5 ft^3	0.5 ft^3
Latent Debris – Fiber[2]	30 lb_m	30 lb_m
Latent Debris – Particulate[2]	170 lb_m	170 lb_m
Foreign Material	500 ft^2	500 ft^2

1) The new sump screen will be designed based on 0.50 ft^3 of unqualified epoxy coatings; this is different than the analysis, which modeled unqualified coatings as Epoxies.

2) 200 lbm of latent debris (fiber plus particulate) is included in the debris loading. Based on Unit 2 latent debris walkdowns, the calculated latent debris for U2 is approximately 33 lb_m.

The above debris does not include debris resulting from chemical effects. Salem uses Sodium Hydroxide (NaOH) as the buffer. An evaluation of the Integrated Chemical Effect Test (ICET) chemical test plan and the SGS 1&2 plant specific parameters has been performed. This preliminary evaluation shows that, (with the exception sump pH and the sump temperature profile), the ICET chemical test parameters bound the SGS 1&2 values.

Sump strainer suppliers are currently developing plans and schedules to quantify the additional head loss associated with Chemical Debris. PSEG plans to evaluate the adequacy of the strainer design and will incorporate chemical effects once the results of the tests to quantify chemical debris effect on head loss have been published. At the same time, an additional evaluation will be performed to determine the impact of the sump pH and the increased temperature profile on the head loss due to chemical effects. Design margins are available to address head loss increases due to chemical effects.

The preliminary NPSH margins increase in head loss due to Chemical effects are as indicated below.

Source of Margin	**Estimated Margin (%*)**	
Analytical Margins	Initial 24 hours after Switchover	After 24 hours
Margin Retained in Sump Screen Procurement Specification	10%	10%
Increased Post-LOCA Minimum Containment Sump Water Level	14%	14%
Expected Conservatism Due to Qualified Coatings Zone of Influence (ZOI) reduction	35%	35%
Additional NPSHa Due to Lower Vapor Pressure at Temperature (74°F) Used for Kinematic Viscosity Increase	0%	>300%
Operational and Procedural Margins		
Reduced Flow Rate Through Sump Screen (single train operation)	0%	45%
Total	59%	>400%

* Percent of strainer design head loss of 3.15 feet

The following table compares the available margins with the margins estimated to be required to accommodate the increased head loss from chemical effects:

	Initial 24 hours after Switchover		After 24 hours	
Chemical Effect	Estimated Margin Required	Margin Available	Estimated Margin Required	Margin Available
Sediment particulate	10%	[redacted]	10%	[redacted]
Precipitate particulate	0%	[redacted]	10%	[redacted]
Sump solution deposition in or reaction with fiberglass	0%	[redacted]	10%	[redacted]
Kinematic viscosity increase	10%	[redacted]	90%	[redacted]
Total	20%	59%	120%	>400%

NRC Requested Information

(d)(iv) The basis for concluding that the water inventory required to ensure adequate ECCS or CSS recirculation would not be held up or diverted by debris blockage at choke-points in containment recirculation sump return flowpaths.

SGS 1&2 Response

(d)(iv)In general, the containment floors are clear of major obstructions that could prevent flow from reaching the containment sump screens. The configuration of the containment basement elevation is conducive to directing flow to the containment sump. The entire basement elevation of the containment building collects water introduced to the containment following a LOCA. Break flow travels from inside the bioshield (the inner annulus) to outside the bioshield (the outer annulus) via the stairwells by the accumulators. The inner annulus is three feet higher than the outer annulus. The inner annulus is essentially an open area except for the primary reactor shield wall, the curbed reactor pit, the supports for the RCPs, S/Gs, and pressurizer, and the walls and supports for the refueling cavity. The flow paths from the upper levels of containment to the lower levels consist of stairwells and grating around the containment perimeter. The RCPs, S/Gs, and pressurizer are inside the bioshield. Other holdup volumes not connected to the recirculation sump have been included in the minimum water level calculation. The refueling canal drains through a 6-inch pipe and valve to the containment floor and from there to the sump. The valve is locked open during normal operation. Therefore, a credible path to the containment pool exists and there is no hold up of inventory in the refueling canal. Furthermore, the path from the refueling canal to the containment floor does not bypass the ECCS suction strainer.

NRC Requested Information

(d)(v) The basis for concluding that inadequate core or containment cooling would not result due to debris blockage at flow restrictions in the ECCS and CSS flowpaths downstream of the sump screen, (e.g., a HPSI throttle valve, pump bearings and seals, fuel assembly inlet debris screen, or containment spray nozzles). The discussion should consider the adequacy of the sump screen's mesh spacing and state the basis for concluding that adverse gaps or breaches are not present on the screen surface.

SGS 1&2 Response

(d)(v) The flow paths downstream of the containment sump were analyzed to determine the potential for blockage due to debris passing through the sump screen. The acceptance criteria were based on WCAP-16406-P (Reference 4).

These evaluations were done for all components in the recirculation flow paths including, but not limited to, throttle valves, flow orifices, spray nozzles, pumps, heat exchangers, and valves. The methodology employed in this evaluation is based upon input obtained from a review of the recirculation flow path shown on Piping and Instrument Diagram Drawings and plant procedures. The steps used in obtaining the flow clearances were as follows:

- Determined the maximum characteristic dimension of the debris (clearance through the sump screen).
- Identified the recirculation flow paths.
- Identified the components in the recirculation flow paths.
- Reviewed the vendor documents (drawings and/or manuals) for the components to obtain flow clearance dimensions.
- Determined blockage potential through a comparison of the flow clearance through the component with the flow clearance through the sump screen.
- Identified the components that require a detailed evaluation and investigation of the effects of debris on their capability to function.

Components with a flow clearance less than or equal to a screen size of 1/12-inch diameter plus ten percent or 0.092 inches are the charging pumps (CV) (wear rings), safety injection (SI) pumps (wear rings), RHR pumps (casing rings), and the fuel assembly. Fuel assembly evaluations are further discussed in (d)(vi).

In addition, the clearance for the RHR pump mechanical seal heat exchanger is greater than 110% of the sump screen size and less than 200% of the sump screen size (0.167 inches).

Evaluation of the high head ECCS throttle valves is currently in progress with the long term wear evaluations discussed in (d)(vi).

As discussed in (d)(vi), the long term downstream evaluations are in progress. The resolution and corrective actions for the above components will be performed with the long term evaluations.

The new strainer will be designed for the effects of weight, thermal, ΔP, and seismic loading. The new strainer is not subjected to jet impingement or missile loads from pipe breaks.

The new strainer design will ensure that gaps at mating surfaces within the strainer assembly and between the strainer and the supporting surface are not in excess of the strainer hole size. Similarly, the design will ensure that drainage paths to the sump that bypass the sump screen will also be within the strainer perforation size.

NRC Requested Information

(d)(vi) Verification that close-tolerance subcomponents in pumps, valves and other ECCS and CSS components are not susceptible to plugging or excessive wear due to extended post-accident operation with debris-laden fluids.

SGS 1&2 Response

(d)(vi) Verification of debris blockage of downstream components is described in (d)(v).

<u>Downstream Components Except Reactor Internals and Fuel</u>

The long term downstream effects evaluation is in progress using the methodology and acceptance criteria presented in WCAP-16406-P (Reference 4). Where excessive wear is found using this methodology, a refined approach using methods such as those described in Department of Energy, Centrifugal Slurry Pump Wear and Hydraulic Studies conducted from October 1982 to December 1987 may be utilized.

For the long term wear evaluations, the quantity and type of debris is derived from the Debris Transport and Head Loss calculations and the sump screen Procurement Specification. The "Minimum Containment Flood Level" calculation is used for the amount of fluid in which the debris will be mixed. Preliminary calculations have been performed for heat exchangers, orifices, and valves based on a conservative value for C_{co} of 0.0007 and decay coefficient of 0.02 for equation 5.8-5 of WCAP-16406-P. The preliminary results are as follows:

- RHR Heat Exchangers show acceptable wear for a required mission time of 120 days.
- Instrumentation required during the post-LOCA recirculation was identified and the corresponding root valves were evaluated for clearance. All clearances were found to be at least three (3) times greater than the screen opening size. An evaluation of instrumentation for debris settling in the instrument lines is in process. No results are currently available.
- Evaluations for the orifices and throttle valves in the SI system, relief valves in the SI and RHR systems, and the CV, SI and RHR pumps and piston (lift) check valves are in progress. No results are currently available.

<u>Westinghouse Evaluation of Reactor Vessel Internals and Fuel</u>

Preliminary Reactor Vessel and Internals Evaluation

Westinghouse Corporation has performed a preliminary evaluation of the reactor vessel and internals using a sump screen hole sized of 1/8-inch. The preliminary evaluation concluded that no blockage of critical flow paths (i.e., flow paths necessary to provide flow to and from the fuel) would occur.

Preliminary Fuel Evaluation

A preliminary assessment of the potential for particulates to restrict flow through the fuel has been made using the guidance contained in NEI 04-07 and associated NRC Safety Evaluation. The preliminary assessment has determined that it is unlikely that particulate debris, by itself, will be deposited on fuel elements such that flow will be impeded.

A final evaluation of the potential for a combination of fibrous and particulate debris to impede flow into and through the core is being performed. Currently, this evaluation is scheduled for completion in the fourth quarter of 2005. The NRC will be advised of the completion of this evaluation through an amendment to this submittal, if necessary.

NRC Requested Information

(d)(vii) Verification that the strength of the trash racks is adequate to protect the debris screens from missiles and other large debris. The submittal should also provide verification that the trash racks and sump screens are capable of withstanding the loads imposed by expanding jets, missiles, the accumulation of debris, and pressure differentials caused by post-LOCA blockage under predicted flow conditions.

SGS 1&2 Response

(d)(vii) The sumps are located outside the missile barriers and any zones of influence of high energy line breaks. Therefore, the strainers are not subject to loads from missiles or expanding jets. The current sump design also includes a 6" curb. Trash racks are not required.

The need for trash racks will be determined during the detailed strainer design phase. The strainers will be designed to withstand the loads imposed by the accumulation of debris and pressure differentials under predicted flow conditions as specified in the design requirements, as well as seismically generated loads.

NRC Requested Information

(d)(viii) If an active approach (e.g., backflushing, powered screens) is selected in lieu of or in addition to a passive approach to mitigate the effects of the debris blockage, describe the approach and associated analyses.

SGS 1&2 Response

(d)(viii) The proposed strainers are of a passive design.

NRC Requested Information

(e) A general description of and planned schedule for any changes to the plant licensing bases resulting from any analysis or plant modifications made to ensure compliance with the regulatory requirements listed in the Applicable Regulatory Requirements

section of this generic letter. Any licensing actions or exemption requests needed to support changes to the plant licensing basis should be included.

SGS 1&2 Response

(e) No changes to the plant licensing bases are currently expected that will require NRC approval.

NRC Requested Information

(f) A description of the existing or planned programmatic controls that will ensure that potential sources of debris introduced into containment (e.g., insulations, signs, coatings, and foreign materials) will be assessed for potential adverse effects on the ECCS and CSS recirculation functions. Addressees may reference their responses to GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," to the extent that their responses address these specific foreign material control issues.

SGS 1&2 Response

(f) PSEG currently implements the following controls for these potential sources of debris.

Insulation used inside of containment is identified on site drawings. In addition, insulation walkdowns were performed to support GL 2004-02. The modification process requires that materials introduced into containment be identified and evaluated for potential impact to the sump and equipment.

The majority of the coatings inside of containment were procured and applied as qualified coatings. Qualified coatings are controlled under site procedures. Unqualified coatings have been identified by location, surface area, and thickness. The majority of unqualified coatings inside of containment are component Original Equipment Manufacturer coatings. New or replacement equipment are evaluated for the potential of unqualified coatings.

At the end of an outage, a formal containment closeout surveillance procedure is performed. The closeout is performed to ensure that loose materials are removed and will not affect the ECCS including the sump. Loose items not removed require a documented evaluation to provide the basis for concluding that the item is acceptable to remain in containment. As part of containment closeout, each ECCS train containment sump and sump screens are inspected for damage and debris. Also, refueling canal drains are verified to be unobstructed and that there is no potential debris sources in the refueling canal area that could obstruct the drains.

PSEG realizes the importance of controlling potential debris sources inside of containment and that debris sources that are introduced to containment need to be identified and assessed. PSEG will ensure that potential quantities of post accident debris are maintained within the bounds of the analyses that support ECCS and CSS recirculation functions. PSEG will review and enhance the procedures associated with the process identified above, or provide new additional controls, as necessary, to ensure that the analyses that support ECCS and CSS recirculation functions remain valid.

These reviews and enhancement to these processes and associated procedures will be incorporated prior to December 31, 2007.

Commitments

The following statements are commitments made by PSEG. Any other statements or dates are provided for information purposes and are not considered regulatory commitments.

PSEG will amend this submittal when:

1. The final designs of the strainers and the Design Change Package are completed. The final design is expected to be issued by the Spring and Fall 2006 with implementations by the Fall 2006 outage for Unit 2 and the Spring 2007 outage for Unit 1. The SGS licensing basis and this response will be revised to reflect the final plant configuration when the design is finalized and plant modifications are completed.

2. The final chemical effects analysis is completed. The final chemical effects analysis will address:
   - The additional head loss associated with Chemical Debris.
   - Performed an evaluation to determine the impact of the sump pH and the increased temperature profile on the head loss due to chemical effects.

   The evaluation is scheduled to be completed by May 31, 2006.

3. The final long-term downstream evaluation is as discussed in (d)(vi) is completed. The final long-term downstream evaluation will address:
   - The RHR Heat Exchangers acceptable wear for a required mission time of 120 days.
   - Finalize the evaluation for debris settling in the instrument lines.
   - Finalize the evaluations for the orifices and throttle valves in the SI system, relief valves in the SI and RHR systems, and the CV, SI and RHR pumps and piston (lift) check valves.
   - Finalize the reactor vessel internals evaluation.
   - Finalize the evaluation of potential for particulates to restrict flow through the fuel.

   The evaluation is scheduled to be completed by January 31, 2006.

PSEG will review and enhance the procedures associated with the process controlling potential debris sources, or provide new additional controls, as necessary, to ensure that the analyses that support ECCS and CSS recirculation functions remain valid. These reviews and enhancement to these processes and associated procedures will be incorporated prior to December 31, 2007.

References:

1. Nuclear Energy Institute (NEI) Document NEI 04-07, Rev. 0, Dated December 2004, "Pressurized Water Reactor Sump Performance Evaluation Methodology."

2. Safety Evaluation by The Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, Nuclear Energy Institute Guidance Report (Proposed Document Number NEI 04-07), "Pressurized Water Reactor Sump Performance Evaluation Methodology."

3. Nuclear Energy Institute (NEI) Document NEI 02-01, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments."

4. Westinghouse Evaluation WCAP-16406-P, dated June 2005, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191."